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MT. KISCO SEWAGE DISPOSAL PLANT[1]

By T. D. L. Coffin and F. E. Hale

DESCRIPTION

Under authority of an act of the New York State legislature of 1907, the city of New York and the village of Mt. Kisco entered into an agreement whereby the city bound itself to build and forever operate a pumping station and sewage disposal plant to care for the sewage of the entire village and in return therefor, the village agreed to construct the necessary trunk and lateral sewers, and to deliver to the pumping station all the sewage of the village.

The village of Mt. Kisco, population 3000, is located in Westchester County, 37 miles from New York City, upon the tributary area of Kisco River, an affluent of Croton Lake entering that reservoir about three miles from the Croton Aqueduct gate house. Owing to this location, and particularly to the topography and character of the soil, which in much of the village is unsuited to local disposal of sewage, the city considered it advantageous to enter into this agreement so favorable to the village.

Plans were prepared for the entire work, and, in the autumn of 1909, work was started, and the plant was put in operation February 1, 1913, the village at that time having completed a portion of one of the three trunk lines of sewers.

The accompanying plan shows the general arrangement of the plant.

PUMPING STATION

The three trunk sewers enter a receiving chamber provided with shear gates so that any one of the trunks may be shut off from the screen chamber in case of a break in the line. Entering the screen chamber, the sewage passes inclined bar screens spaced 1½ inches in the clear, then through similar screens spaced ⅝ inch in the clear into a storage compartment 20 feet by 8 feet, having an ordinary fluctuation in water level of 5 feet 6 inches though the sewage

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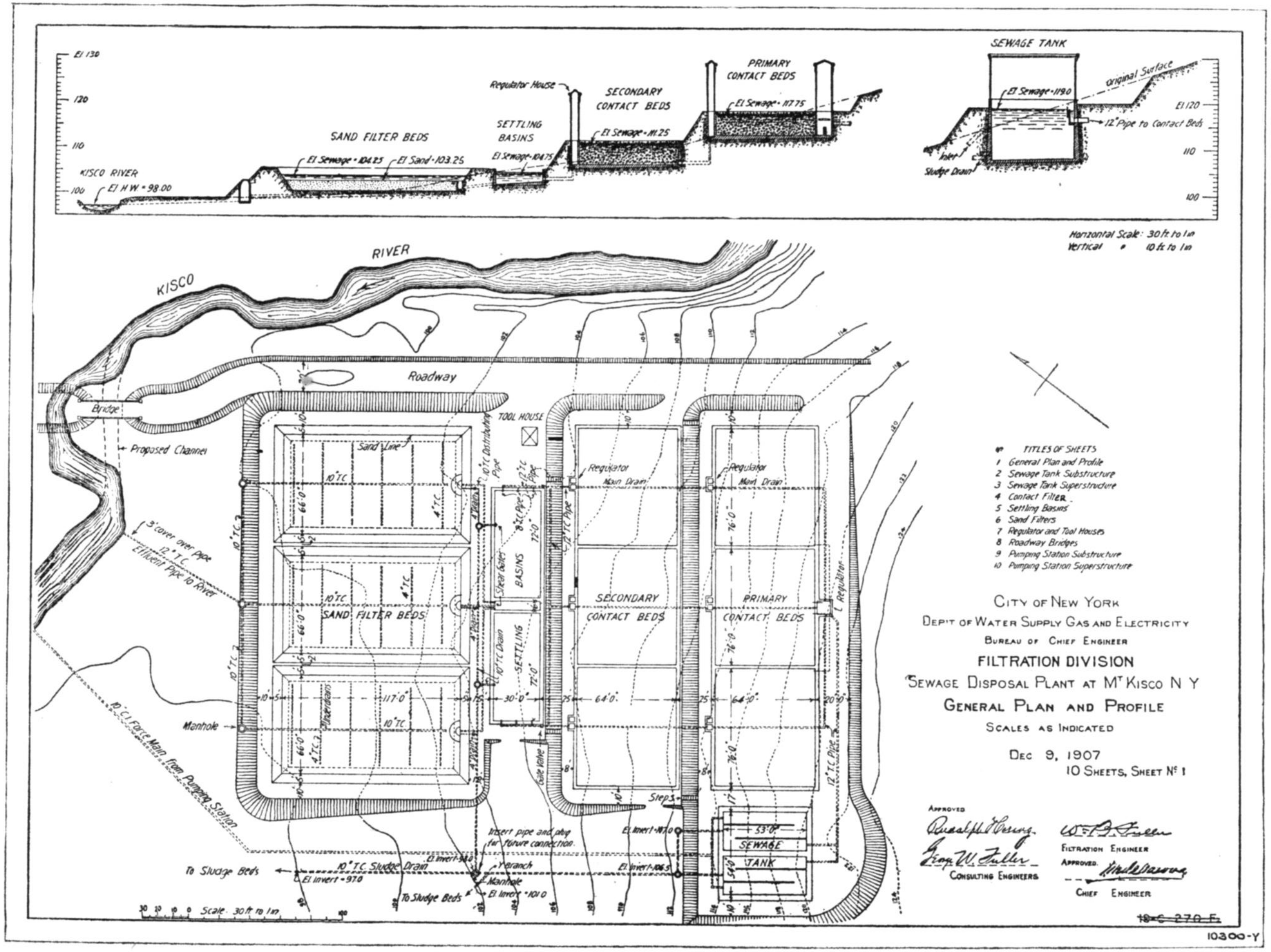
[1] **Description of plant by T. D. L. Coffin. Analytical by F. E. Hale.**


El 130
120
110
100
KISCO RIVER
El H W = 98.00
SAND FILTER BEDS
El Sewage = 104.25
El Sand = 103.25
SETTLING BASINS
El Sewage = 104.75
Regulator House
SECONDARY CONTACT BEDS
El Sewage = 111.25
PRIMARY CONTACT BEDS
El Sewage = 117.75
SEWAGE TANK
El Sewage = 119.0
Original Surface
Inlet
Sludge Drain
12" Pipe to Contact Beds
El 120
Horizontal Scale: 30 ft to 1 in
Vertical " 10 ft to 1 in
KISCO
RIVER
Roadway
Bridge
Proposed Channel
3' cover over pipe
12" T.C.
Effluent Pipe to River
10" C.I. Force Main from Pumping Station
Manhole
TOOL HOUSE
Sand Line
10" T.C.
4" T.C.
SAND FILTER BEDS
Underdrains
10" T.C. Distributing Pipe
12" T.C. Pipe
8" T.C. Pipe
Shear Gates
SETTLING BASINS
10" T.C. Drain
4" Drain
Gate Valve
117'0"
66'0"
72'0"
30'0"
64'0"
76'0"
20'0"
53'0"
54'0"
Regulator
Main Drain
12" T.C. Pipe
SECONDARY CONTACT BEDS
PRIMARY CONTACT BEDS
Regulator
Steps
SEWAGE TANK
El Invert = 117.0
El Invert = 106.5
Insert pipe and plug for future connection.
El Invert = 98.0
Y Branch
Manhole
El Invert = 101.0
10" T.C. Sludge Drain
To Sludge Beds
El Invert = 97.0
To Sludge Beds
30 20 10 0 Scale 30 ft to 1 in
TITLES OF SHEETS
1 General Plan and Profile
2 Sewage Tank Substructure
3 Sewage Tank Superstructure
4 Contact Filter
5 Settling Basins
6 Sand Filters
7 Regulator and Tool Houses
8 Roadway Bridges
9 Pumping Station Substructure
10 Pumping Station Superstructure
CITY OF NEW YORK
DEP'T OF WATER SUPPLY GAS AND ELECTRICITY
BUREAU OF CHIEF ENGINEER
FILTRATION DIVISION
SEWAGE DISPOSAL PLANT AT MT KISCO N Y
GENERAL PLAN AND PROFILE
SCALES AS INDICATED
DEC 9, 1907
10 SHEETS, SHEET No 1
APPROVED
Rudolph Hering
Geo. W. Fuller
CONSULTING ENGINEERS
W. P. Fuller
FILTRATION ENGINEER
APPROVED
CHIEF ENGINEER
~~18-C-270-F.~~
10300-Y

may rise 11 feet above normal before overflowing the receiving chamber. Separated from the screen chamber by a solid concrete wall, is the pump sump 10 feet by 22 feet by 19 feet in height. In this chamber are mounted two horizontal high efficiency, centrifugal pumps, of a capacity of 350 gallons per minute each and one horizontal, low efficiency, centrifugal pump, of a capacity of 450 gallons per minute. These pumps discharge against a head of 45 feet due to the elevation of the point of discharge and to the friction in the force main. The two pumps first mentioned are operated by 10 h.p., two phase, 60 cycle, 220 volt, 900 r.p.m. induction motors. These motors are started and stopped by the rising and falling of the sewage in the screen chamber. The third, or auxiliary, pump is operated by a 20 h.p. horizontal, gasoline driven engine. This pump is held in reserve for use when the electrically operated apparatus is undergoing repair; when there is an interruption in the electrical power service, or when, due to high water over the trunk sewers, there is an infiltration of ground water which, coupled with the normal sewage flow, is in excess of the capacity of the electrically operated pumps.

SEWAGE TANK

The sewage is discharged from the pumping station through a 10-inch cast iron force main 3700 feet in length to the sewage tank. This is an enclosed, dual, concrete chamber, each compartment having a sewage capacity of 100,000 gallons and an average depth of 10 feet 3 inches below the flow line. Two baffle walls divide each chamber into three compartments 8 feet wide. The pumped sewage enters the chamber 5 feet above the bottom and flows the entire length of the baffled chamber, or 156 feet, to the outlet weir, so constructed that the discharge is drawn from a point 24 inches below the surface. Between the two compartments there is a wall of dimensions ample to withstand the pressure resulting from one full and one empty chamber. Twenty-five piers, together with the side walls, support the superstructure. The bottoms of the tanks have a drop of 6 inches toward a depression reaching a foot in depth at the 10-inch sluice gate provided for discharging the sludge from the chamber. Each chamber is provided with a 6-inch supernatant liquid drain connecting with the second contact bed. Over the top of the division wall, and two of the baffle walls, and about the sides of the building, concrete platforms, or walks, are provided. The superstructure is of concrete, the roof only being reinforced.

REGULATOR HOUSE

From the outlet weir of the sewage tank, the liquid is drawn through a 12-inch terra cotta drain to the regulator house, in which is an Ansonia apparatus for discharging the liquid into one of three contact beds. Sewage may be discharged into all three contact beds in rotation, or into any two contact beds alternately. As the pumpage of sewage is intermittent with low sewage flows, it is apparent that the duration of discharge into any contact bed of the first series is variable.

CONTACT BEDS

There are six contact beds: three primary, receiving the sewage after tankage, and three secondary, receiving the effluent of the primary contact beds. All six beds are identical in size and detail. Each bed is 76 feet by 64 feet in area, has an end depth of 4 feet 6 inches and a center depth of 5 feet. Through the center of each bed there is a depression 15 inches wide with a depth increasing from 6 inches to 12 inches from inlet to outlet end. The entire bottom of the bed is covered with parallel rows of 6-inch half round tile, with open joints. A concrete cover over the center drain rests on top of these tile collectors. The bed is filled with broken stone to the top of the side walls, although the flow line is 6 inches below these walls. As the inlet and outlet are at the bottom, this depressed flow line prevents aerial nuisance. The sewage capacity of each contact bed is about 50,000 gallons. An Ansonia regulator at the end of the main drain discharges the sewage from the primary to the secondary contact beds and from the secondary beds into two settling tanks. This apparatus is such that the height to which any bed is filled may be predetermined, and one, two, or three beds of either series may be operated, but the time of contact depends upon the time of filling of the next bed in series. Stated differently, the time of contact depends upon the rate of sewage flow.

SETTLING BASINS

The effluent of the second contact bed is discharged into one or both of two settling tanks, each having a surface area 2160 square feet and a depth below the overflow lip varying from 3 to 4 feet. These basins discharge into a common channel from which the flow may be directed onto one of three sand filters. The deposit from the settling basin may be drawn off to sludge filters as required.

SAND FILTERS

The sand filters, three in number, have a combined sand area of half an acre, a sand depth of 30 inches, and an effective size of 0.35 mm. Many analyses of the sand were made at the bank and by careful selection a very uniform sand was secured. These filters are enclosed with earth embankments and at the intersection of the slopes and sand surface a 3-inch by 10-inch hard pine plank, placed vertically, marks the limit of the filtering area and prevents the washing of silt on to the sand surface. The collector system of each bed consists of 300 feet of 4-inch open joint tile, surrounded with gravel and discharging into a 10-inch collector laid longitudinally through the bottom of the bed.

CHLORINATING APPARATUS

At the manhole where the three collectors join, a bleach plant is placed and the chlorinated effluent, after a short detention in an open basin, is discharged into Kisco River. The amount of chlorine applied varies from 10 to 20 p.p.m., depending upon the rate of sewage flow.

SLUDGE DISPOSAL

The sludge from the sewage tank is discharged by gravity flow into one of five sludge pits; i.e., hemlock sheathed trenches, 80 feet long, 10 feet deep and 6 feet wide. At the discharge end of each trench there is an 8-inch tile pipe with vertical inlet with lip to be set at any desired elevation. This arrangement permits of drawing off the partially clarified liquid from the top and leaving the sludge at the bottom. It is the intention to abandon the trenches when filled with sludge. The liquid from these trenches, as well as the sludge from the settling basins, is discharged upon a sand filter 100 feet by 100 feet in area and 12 to 18 inches deep with a trench through the center extending down through hardpan into a waterbearing stratum beneath. From this bed there is an overflow weir with bleach tank above so that excess water may be chlorinated and discharged onto low lying land which eventually drains to a tributary of Kisco River, a quarter of a mile distant.

The plans from which this plant was built were prepared under the direction of Wm. B. Fuller, of Hering and Fuller, consulting engineers, and I. M. de Varona, chief engineer, bureau of water supply. John W. Heller, of Newark, N. J., was the general contractor.

The cost of the plant was as follows:

Pumping station building and disposal plant	$64,526.00
Sludge trenches and filters, fences, etc	7,027.00

Included in the first item is $16,000 for roadway and fencing.

In general, though the plant has proved most satisfactory in operation, delivering a clear, non-putrescible, practically germless effluent, there are minor details which, in the light of operating experience, might be modified to advantage. This and the following statements are without bias, and solely as an aid to others who may be called upon to design somewhat similar plants.

1. The screen chamber at the pumping station does not afford convenient means for the removal and disposal of screenings. These must be hoisted to the surface and carted in a watertight scavenger's wagon to a point of ultimate disposal. Had the electrically operated pumps had larger waterways, though their economy of power would have been somewhat lessened, the amount of material to be removed by hand would have been decreased. The amount of sludge and screenings to be removed amounts to about 16 cubic yards per month and it is necessary to dismantle the smaller pumps and clean their waterways about twice a month.

2. On one occasion the regulating apparatus between the sewage tank and the primary contact beds stuck during the night and an overflow of sewage occurred. An overflow lip directly to the surface of a contact bed would obviate this condition.

3. On more than one occasion, the regulating apparatus between the contact beds has failed in its operation and the beds have overflowed. A weir between each bed is indicated as a precautionary measure.

4. From an earlier statement and from remarks to follow by Dr. Hale, it is apparent that the primary contact beds serve as charging chambers for the secondary beds rather than as contact beds. An arrangement of piping to carry the tank effluent to a plane near the stone surface and there permit the liquid to trickle over the stone might increase the efficiency of these beds.

5. Hemlock is not a sufficiently lasting material as sheeting for the sludge trenches.

6. Last summer, the sand filters without thorough draining were horse cultivated. This by winter caused a compacting of the upper layers of sand which materially lessened the rate of filtration, and reduced the nitrification previously secured. A thorough hand cultivation when dry was necessary to restore these filters and in future it is intended to scrape, cultivate, or otherwise work these beds only when in a thoroughly dry condition.

ANALYTICAL

Samples are taken once a week upon the same day, representing each stage of treatment, and given complete examination, physical, chemical and bacteriological. The chlorinated effluent, however, is examined only bacteriologically, but is usually sampled daily, Sundays excepted. The determinations made consist of turbidity, Kjeldahl nitrogen, (in solution, in suspension, and total), free ammonia, nitrite, nitrate, total solids, suspended solids, loss on ignition, fixed solids, chlorine, free carbonic acid, putrescibility, bacteria at 37°C., and presumptive test for *B. coli.*

Methods need only slight comment. Turbidity is determined as in water analysis by the candle turbidimeter. The nitrogens are determined by distillation, not direct nesslerization; nitrate by phenol-sulphonic acid method; suspended solids by the Gooch crucible; carbonic acid by titration; putrescibility by varying dilutions with aerated distilled water and incubation at 37°C., for five days. The bacteria count is the total growing in one day on agar at 37°C.; and the *B. coli* is the presumptive test of 20 per cent gas within three days in lactose peptone bile at 37°C., dilutions of sewage by tenths being tested up to the millionth of a cubic centimeter.

The following table (1) shows the average figures for the year 1915 together with percentage removal at each stage of the amount of material entering that stage and also the total percentage removal of the complete plant.

It will be noticed at once that the "septic tank", a term commonly used to describe several forms of sewage tanks in which septic action takes place, and the sand filters perform the heaviest amount of work. The septic tank is particularly efficient. It removed 81 per cent of the suspended solids as weighed, 66 per cent expressed

TABLE 1

The City of New York, Department of Water Supply, Gas and Electricity, Mt. Kisco Laboratory, Mt. Kisco Sewage Disposal Plant, 1915 Averages and Amount of Purification.

SAMPLE	PHYSICAL EXAMINATION		CHEMICAL ANALYSIS (PARTS PER MILLION)													BACTERIOLOGICAL EXAMINATION								
			Nitrogen as														B. coli.							
			Kjeldahl ammonia																					
Place of collection	Turbidity (parts per million of silica)	Color (parts per million of platinum)	In solution	In suspension	Total	Free ammonia	Nitrite	Nitrate	Total solids	Suspended solids	Loss on ignition	Fixed solids	Chlorine	Putrescibility (oxygen demand)	Free carbonic acid	Number of bacteria per cc. 24 hours at 37.5°C.								
														O	CO₂		cc .001	cc. .0001	cc. .00001	cc. .000001	cc. .01	cc. 0.1	cc. 1	cc. 10
Average analyses																	%	%	%	%	%	%	%	%
Raw sewage (P.S.)	239		14.1	10.5	24.6	23.9	0.125	0.52	575	231	276	299	49	153	40.8	1,480,000	37	84	98	100	100	100	100	100
Septic tank effluent	81		3.9	3.0	6.9	12.2	0.058	0.31	307	44	104	203	41	90	45.0	400,000	22	49	92	100	100	100	100	100
First contact bed effluent	83		4.3	3.2	7.5	12.6	0.062	0.31	323	45	106	217	45	81	44.5	560,000	20	59	92	100	100	100	100	100
Second contact bed effluent	63		3.6	2.8	6.4	10.9	0.111	0.29	288	26	77	211	45	45	48.6	470,000	16	59	92	100	100	100	100	100
Settling basin effluent	53		2.8	2.3	5.1	9.5	0.072	0.15	279	21	69	210	46	27	48.5	460,000	14	49	90	100	100	100	100	100
Sand filter effluent	10	27			0.419	3.74	0.033	2.74	299		64	235	46	0	66.7	38,000	0	10	60	83	100	100	100	100
Filter effluent chlorinated																38						4	8	39
Percentage removal for each stage	%		%	%	%	%			%	%	%	%		%	%	%								%
Septic tank	66		72	71	72	49			47	81	62	32		41	+10	72								40
First contact bed	+2		+10	+7	+9	+3			+5	+2	+2	+7		−10	−1	+40								−4
Second contact bed	24		16	13	15	13			11	58	27	3		44	+9	16								15
Settling basin	16		22	18	20	13			3	19	10	0		40	0	2								13
Sand filter	81				92	61			+7		7	+12		100	+38	92								91
Chlorination																99.9								99 997
Total plant	96				98	84		+527	48		77			100	+63	99.997								99.9999

as turbidity, 71 per cent expressed as nitrogen of suspended matters. Considering other important determinations there were removed 72 per cent organic nitrogen, 41 per cent putrescible matter, 72 per cent bacteria, and 40 per cent *B. coli*.

Owing to design the first contact beds have accomplished practically nothing as to purification, most of the figures showing a slight increase. They do serve as storage for regulation of flow into the second contact beds. The second contact beds show some purification of the matter reaching them, 24 per cent removal of turbidity, 58 per cent suspended solids, 13 per cent nitrogen of suspended matter, 15 per cent of organic nitrogen, 44 per cent putrescible matter, 16 per cent bacteria, and 15 per cent *B. coli*. Apparently these contact beds so worked over the material that purification progressed to about an equal extent in the settling basins.

The removal in the settling basins was 16 per cent turbidity, 19 per cent suspended solids, 18 per cent nitrogen of suspended solids, also 20 per cent organic nitrogen, 40 per cent putrescible matter, 2 per cent bacteria, 13 per cent *B. coli*.

The sand filters performed excellent work. Of the turbidity 81 per cent was removed, organic nitrogen 92 per cent, putrescible matter 100 per cent, bacteria 92 per cent, *B. coli* 91 per cent. It will be noticed that there was an increase in fixed solids due to fixation of oxygen as nitrate and of carbonic acid as carbonates.

Chlorination of the effluent removed 99.9 per cent of the bacteria and 99.997 per cent of the *B. coli*.

The percentage removal for the total plant referred to the raw sewage was as follows:

Turbidity 96 per cent, organic nitrogen 98 per cent, putrescible matter 100 per cent, bacteria 99.997 per cent and *B. coli* 99.9999 per cent. The chlorinated effluent, except for free ammonia, would compare well with many drinking waters, usually being clear, with hardly noticeable color, free from bacteria and with the absence of *B. coli* in 10 cc. It would, however, taste of chlorine.

The following table (2) compares the loss of nitrogen at each stage with the production of free carbonic acid.

It would appear that the consumption of nitrogenous material with the loss of nitrogen as a gas is a more important function of the septic process than the consumption of carbonaceous material.

Both nitrogenous and carbonaceous material appear to have been abundantly consumed in the filter beds. Of the total nitrogen worked over by the sand filters 25 per cent was oxidized to nitrate and 75 per cent lost as a gas. This same ratio was true of a trickling filter effluent at another plant. Judging from the nitrogen loss, the septic tank produced 70 per cent of the total chemical purification effected, the contact beds and settling basins 11 per cent, and the sand filters 19 per cent.

The purification previous to chlorination is well represented upon the accompanying diagram, No. 1, in which the abscissa represents the average time for each stage in the purification. Different scales of magnitude are employed for the various determinations on the ordinate in order to bring out the proper correlation.

The best measure of purification is the putrescibility, expressed as parts per million of oxygen demand. This line shows how the organic material has been worked over and stabilized even when chemical analyses do not show equal results.

TABLE 2

Removal of total nitrogen and production of carbonic acid

	TOTAL NITROGEN LOSS	PER CENT REMOVAL OF TOTAL NITROGEN	INCREASE OF CARBONIC ACID
	ppm.	*per cent*	*ppm.*
Septic tank	−29.6	70	+ 4.2
First contact bed	+ 1.0	?	− 0.5
Second contact bed	− 2.8	4	+ 4.1
Settling basin	− 2.9	7	− 0.1
Sand filters	− 7.9	19	+18.2

The septic tank shows a reduction in suspended and total solids, turbidity, organic nitrogen of suspended matter, and free ammonia proportional to the drop in putrescibility, and even a greater drop in organic nitrogen, also a slight increase in carbonic acid.

The first contact beds show a slight drop in putrescibility although chemically there appears to be no purification, the average figures showing a slight increase probably due to chance in sampling a very variable sewage.

The second contact beds show a considerable drop in putrescibility although only a slight decrease in chemical determinations and a slight increase in carbonic acid. However, despite the slight chemical changes, the decrease in putrescibility of the combined contact beds is nearly equal to that produced by the septic tank and, moreover, the contact beds have apparently such an influence on

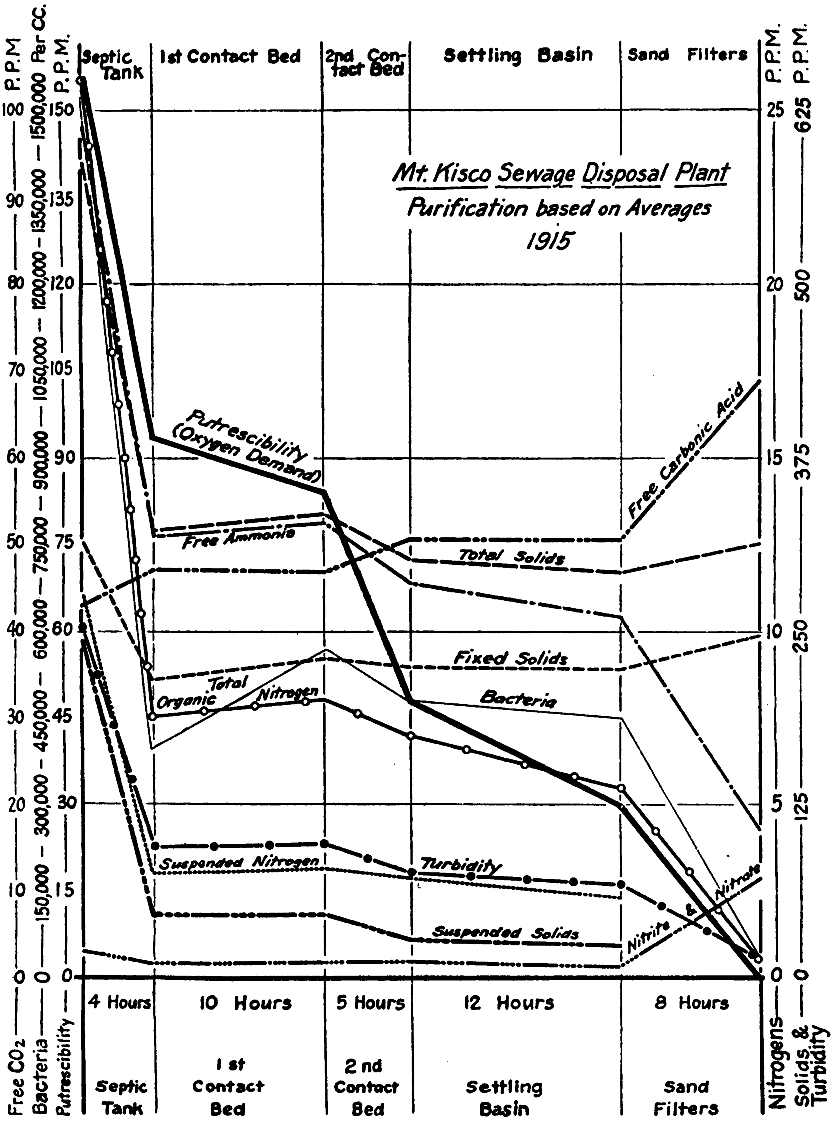

Septic Tank
1st Contact Bed
2nd Contact Bed
Settling Basin
Sand Filters
Mt. Kisco Sewage Disposal Plant
Purification based on Averages
1915
Putrescibility (Oxygen Demand)
Free Carbonic Acid
Free Ammonia
Total Solids
Fixed Solids
Total Organic Nitrogen
Bacteria
Suspended Nitrogen
Turbidity
Suspended Solids
Nitrite & Nitrate
0 10 20 30 40 50 60 70 80 90 100 P.P.M
0 150,000 300,000 450,000 600,000 750,000 900,000 1050,000 1200,000 1350,000 1500,000 Per CC.
0 15 30 45 60 75 90 105 120 135 150 P.P.M.
0 5 10 15 20 25 P.P.M.
0 125 250 375 500 625 P.P.M.
4 Hours
10 Hours
5 Hours
12 Hours
8 Hours
Septic Tank
1st Contact Bed
2nd Contact Bed
Settling Basin
Sand Filters
Free CO₂
Bacteria
Putrescibility
Nitrogens
Solids & Turbidity

DIAGRAM 1

the sewage that purification continues in the settling basins as shown by a considerable drop in putrescibility, although accompanied again by only slight changes in chemical analysis. This result is not due to sedimentation merely, as is shown by the turbidity and solids figures.

The sand filters complete the drop in putrescibility accompanied by a sharp decrease in turbidity, free ammonia and organic nitrogen, and an increase in nitrate, carbonic acid, total and fixed solids, the last two due to the fixation of oxygen and carbonic acid.

While there seems to be no particular reason why it should be so, it is noticeable that the total bacteria (37°C.) line follows in a general manner the other lines, showing a heavy drop in the septic tank, an increase in the first contact beds, a slight decrease in the second contact beds and sedimentation tanks, and a sharp drop in the sand filters. Probably there is a connection between food value and its amount and the total number of bacteria. The test for *B. coli* shows a corresponding decrease although not charted.

The finishing touch to the purification is given by the chlorination. Its efficiency is shown by daily analyses as embodied in the following table (3):

TABLE 3

Efficiency of chlorination as shown by the number of samples with varying amounts of bacteria in the chlorinated effluent

BACTERIA PER CC. AGAR AT 37°C.	NUMBER OF SAMPLES	PER CENT OF TOTAL SAMPLES EXAMINED
		per cent
0	103	36
1–10	81	29
11–50	81	28
51–100	15	5
101–2000	6	2
	286	100

The plant works under great disadvantages in that it treats an extremely variable sewage, from strong sewage to almost pure ground water. This undoubtedly interferes with proper bacterial growth and activity. The following diagram (No. 2) shows the fluctuations throughout the year of the analyses of the sand filter effluents.

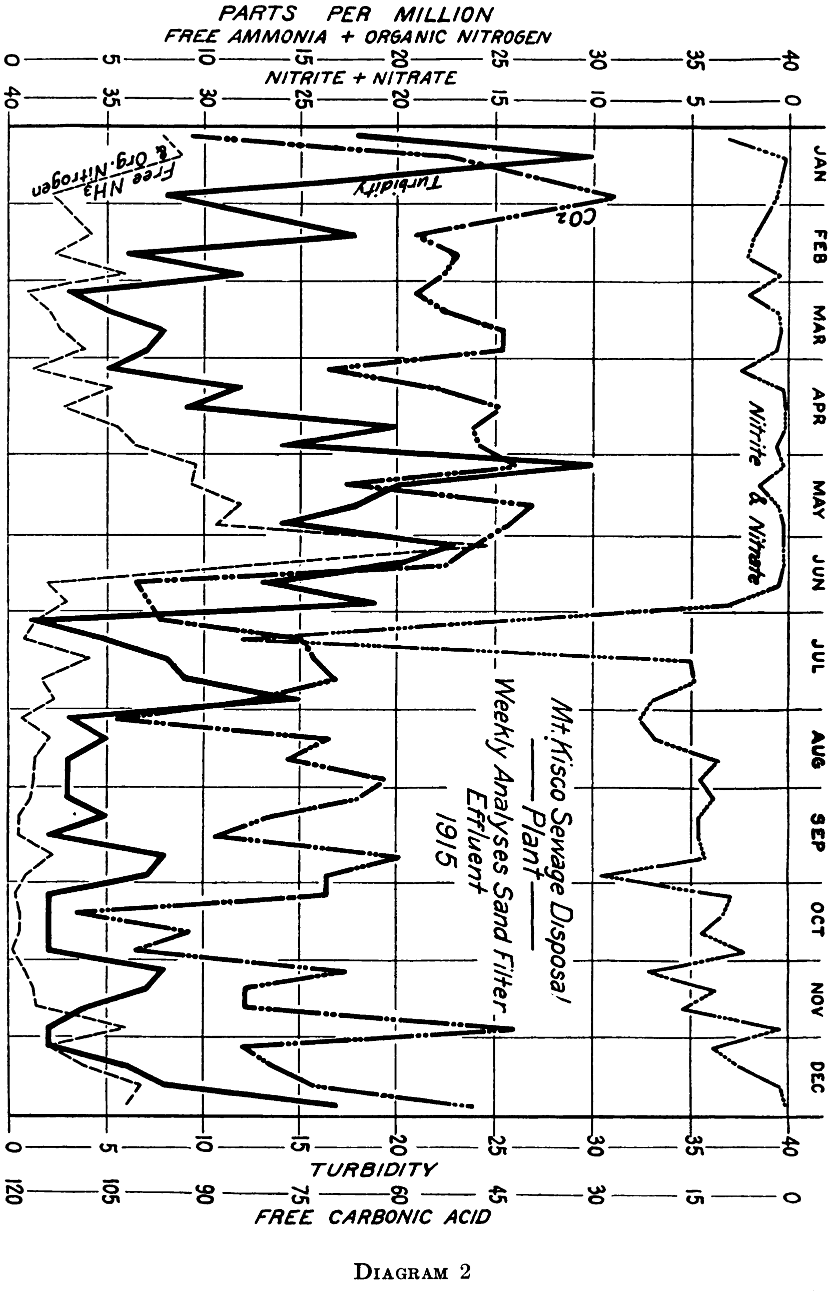

PARTS PER MILLION
FREE AMMONIA + ORGANIC NITROGEN
0 5 10 15 20 25 30 35 40
NITRITE + NITRATE
40 35 30 25 20 15 10 5 0
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC
Turbidity
CO_2
Free NH_3 & Org. Nitrogen
Nitrite & Nitrate
Mt. Kisco Sewage Disposal Plant
Weekly Analyses Sand Filter Effluent 1915
0 5 10 15 20 25 30 35 40
TURBIDITY
120 105 90 75 60 45 30 15 0
FREE CARBONIC ACID

DIAGRAM 2

The turbidity and sum of free ammonia and organic nitrogen are plotted from the base line and the carbonic acid and sum of nitrite and nitrate from the top on an inverted scale. In a general way the lines conform. It will be noted that inferior results occurred in January and in April, May and June.

It is only by constant attention that satisfactory results are obtained coupled with the supreme help of chlorination. There is also the tremendous dilution of the purified effluents. While the average figures for the year for the entire plant show an excellent purification, nevertheless, the safety of our water supply must rely upon eternal vigilance.

DISCUSSION

Mr. Paul Hansen: The speaker was very much interested in this paper, both because of the unique character of the plant and because of some of the rather unusual results that were obtained in its operation. It would be very enlightening to have a statement of the rates of application of sewage that are used on the filters, and also to know how the unusually high efficiency of the septic tank is obtained.

Mr. Theodore DeLong Coffin: As to the rates in the various parts of the plant, one of the charts which Dr. Hale showed gives the average time that the sewage is in contact within the various parts of the plant. That is not true for any specific time necessarily, because we have a great deal of ground water to contend with.

Mr. Paul Hansen: What is the population of the town?

Mr. Theodore DeLong Coffin: Three thousand people.

Mr. Paul Hansen: How would you express it in gallons per acre?

Mr. Theodore DeLong Coffin: The sand filters will care for 6000 people to the acre. The average flow of the sewage is not far from one third of a million gallons per day. At times it is as low as 200,000 gallons, and at times three times that quantity, or over half a million gallons.

Mr. John H. Gregory: What is the size of the screens?

Mr. Theodore DeLong Coffin: There are 1½ inch bar screens and ⅜ inch bar screens.

Mr. John H. Gregory: Is there any grit chamber?

Mr. Theodore DeLong Coffin: A small one.

Mr. John H. Gregory: Is it found necessary to use the auxiliary gasoline pump, or can reliable operation be obtained with the electrically operated pumps?

Mr. Theodore DeLong Coffin: It cannot be operated at all times of the year with the electrical operating pumps. Part of the trouble is produced by storms in the summer. The current is interrupted, and then the gasoline engine and pump are resorted to. At other seasons of the year, that is, early in the spring, there are great quantities of ground water which are in excess of the capacity of the electrical pumps, even though the quantity of the sewage running out is not in excess of the capacity of those pumps. After it rains continuously for some time, the electric pumps, on account of their very small water way and high efficiency, clog up, and the gasoline pumps are used; at other times one of the electrically operated pumps is out of service, for repairs, when necessarily the gasoline pump is put in service.

Mr. John H. Gregory: How frequently is it necessary to clean the pumps?

Mr. Theodore DeLong Coffin: About twice per month.

Mr. John H. Gregory: The septic tank is divided into compartments, is it not?

Mr. Theodore DeLong Coffin: Yes, two compartments.

Mr. John H. Gregory: Is one compartment allowed to stand after the sludge has accumulated?

Mr. Theodore DeLong Coffin: Usually for about six months. The tank is operated for six months, and then there is a lapse of about six months before it is put into service again. In the meantime it stands full of sludge.

Mr. John H. Gregory: Is the electric current purchased by the City of New York or does the city produce it?

Mr. Theodore DeLong Coffin: It is purchased.

Mr. C.-E. A. Winslow: What is the comparative bacteriological condition of the effluent and of the stream into which it flows?

Mr. Frank E. Hale: It is much better than the stream into which it flows.

Mr. C.-E. A. Winslow: Is that uniformly the case?

Mr. Frank E. Hale: Yes.

Prof. R. L. Sackett: The plant described presents very interesting features, and in very unusual combinations. The description of the plant and the analysis of the effluent raise in the minds of a number of us, very pertinent questions. On the charts showing the analyses, the tank treatment showed up very well in all its features; then came the contact beds, in which there seemed comparatively little advantage. The filters themselves produce a satisfactory service, and the sedimentation and then the chlorination apparatus; but one naturally asks, would not screening first, then tank treatment, and comparatively thorough filtration, followed by tank treatment and chlorination give equally good results, and with greater simplification? To be sure, it must be realized that this plant has unusual attention. In this country a considerable number of plants of equal size do not have this same expert and continuous attention. The point is directed more to the advantage of simplicity of parts. It would seem that under other circumstances, at least, some simplification in the plant would lead to as good results, at a less expenditure, and to simplification of operation. The filters were cultivated to some depth, and the result was that the organic matter which had accumulated on the surface was cultivated down to a point below the surface, and covered over; that will lead to a condition there of stagnation of organic matter, and is calculated to fill up the pores of the filter with more material than it otherwise would. Experience has shown that the surface should not be disturbed to any considerable depth, thus putting the filter out of operation the shortest possible time, and permitting the very easy removal of the organic matter which collects on the surface, and that no considerable amount of the surface needs to be disturbed at all.

Mr. John R. Downes: The speaker thinks it a mistake to conclude that the beds do little good, or have little good effect. The work of the septic tanks and primary beds is simply preparatory to the work which is to be done by the final beds; at Plainfield, New Jersey, there are plain settling tanks and primary and secondary filter or contact beds, and while the primary beds do not produce any marked change, discernible in chemical terms, they do a valuable service in preparing the sewage for the final treatment. Certainly sand filters would not accomplish the work that they do, were it not for the preparatory effect of the contact beds. Each step in the process should be considered as simply preparatory to the next step and the treatment in the final bed as a preparation for the final dilution in the stream. By making "Dissolved Oxygen Consumed" tests you will be able to interpret into chemical terms a part, at least, of the preparatory effect of each step which can be shown in no other way.

In a paper before the New Jersey Sewage Works Association the speaker described an experiment comparing the mechanical aeration of (a) tank effluent, (b) primary effluent, and (c) tank effluent to which dirty cinders from the secondary beds were added. The effect of the retained "activator" in the primary effluent was very clearly shown, as was that of the "activator" supplied from the cinders in the third case.

Mr. M. N. Baker: What did New York City help pay for? Did it help pay for the sewerage system in the village, the trunk sewers and the disposal works, or only the disposal works, and how was that cost divided, that is, what proportion did the village pay and what proportion did the city pay; and also how was the cost of the operation divided between the city and the village? Who constructed the plant—did New York City design and construct the plant; and who operates the plant, the village or New York City?

Mr. Theodore DeLong Coffin: The agreement provided that the village should deliver all the sewage of the village to the pumping station, and the village has built the sewers to the pumping station. At the pumping station the plants of the city of New York begin; there the expense to the city begins. It built the pumping station and the disposal plant; it operates the pumping station and the disposal plant; and the village operates its sewer line to the pumping station.

Dr. D. P. Curry: What is the cost of this plant, the per capita cost, for installation and operation?

Mr. Theodore DeLong Coffin: The plant cost $70,000 in round figures. The population is 3000.

Dr. D. P. Curry: Does that include the pumping station or simply the sewage disposal plant proper?

Mr. Theodore DeLong Coffin: The pumping station and disposal works.

Mr. Frank E. Hale: The speaker would like to make one statement in regard to the contact beds. It was not his intention to give the impression that the contact beds were doing as efficient work as contact beds should do. Apparently they are not operating correctly. The highest efficiency is not claimed for them, but they are accomplishing a certain amount of necessary work; they were installed in order to avoid a nuisance; there is no doubt that trickling filters or other methods might produce a greater efficiency, but we have the minimum nuisance. The contact beds work over material, so that, after it leaves them, the purification still goes on in the settling basin. In the light of experience, improvement can be made.

Dr. D. P. Curry: You are contending with conditions peculiar to that particular section?

Mr. Theodore DeLong Coffin: Yes.

Mr. C. A. Haskins: How is chlorine added to the effluent in the sand filter, and how long a period of contact is allowed, and how far below that point are samples collected? The figures given by Dr. Hale seem rather high.

Mr. Theodore DeLong Coffin: The rate of the application of the chlorine is on the average as Doctor Hale gave it; but there is a variation in the application, due to the fact that the filters are not filtering continuously; they receive their charges of sewage as the contact beds empty. Therefore the rate is very variable. In order to "dose" the maximum flow an excess quantity of chlorine is used, which brings the average high. The chlorine is run as a solution into the man-hole through which all the effluent from the plant is passed, and from this man-hole the effluent is run out into a tank which is perhaps thirty feet long and twenty feet wide, the treated effluent circulating through the tank, and discharging directly into the river. There is at no time more than half an hour elapsing between the time of applying the chlorine and the time the chlorinated effluent reaches the stream. A sample of the chlorinated effluent is picked up as the effluent reaches the river.